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TITLE MEASUREMENT OF SPIN OBSERVABLES IN PION-NUCLEON SCATTERING  
AT LAMPF

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# MEASUREMENT OF SPIN OBSERVABLES IN PION-NUCLEON SCATTERING AT LAMPF

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Interest in the pion-nucleon system is increasing due to new data of high precision<sup>1-6</sup> and to recent theoretical developments. Among the latter are results from quark models<sup>7</sup>, the Skyrmin model<sup>8</sup>, and the hybrid model<sup>9</sup>. Predictions for positions, widths and decay modes of resonances, for relations between isospin amplitudes, and for possible new resonances have contributed to the enthusiasm.

Of particular interest is the debate on whether the  $P_{11}$  resonance is split. Originally proposed by a Saclay<sup>10</sup> partial wave analysis (PWA), the latest adherent of two low-lying  $P_{11}$ 's is the VPI group<sup>11</sup> which reports poles in the complex plane at (1359, -100i) and (1410, -80i) MeV. The PWA's from the Karlsruhe-Helsinki<sup>12</sup> and CMU-LBL<sup>13</sup> groups do not support this conclusion. To further complicate the issue, it has been shown<sup>14</sup> that resonance-like behavior in the  $P_{11}$  wave could be caused by the opening of the  $\pi N \rightarrow \pi \Delta$  channel.

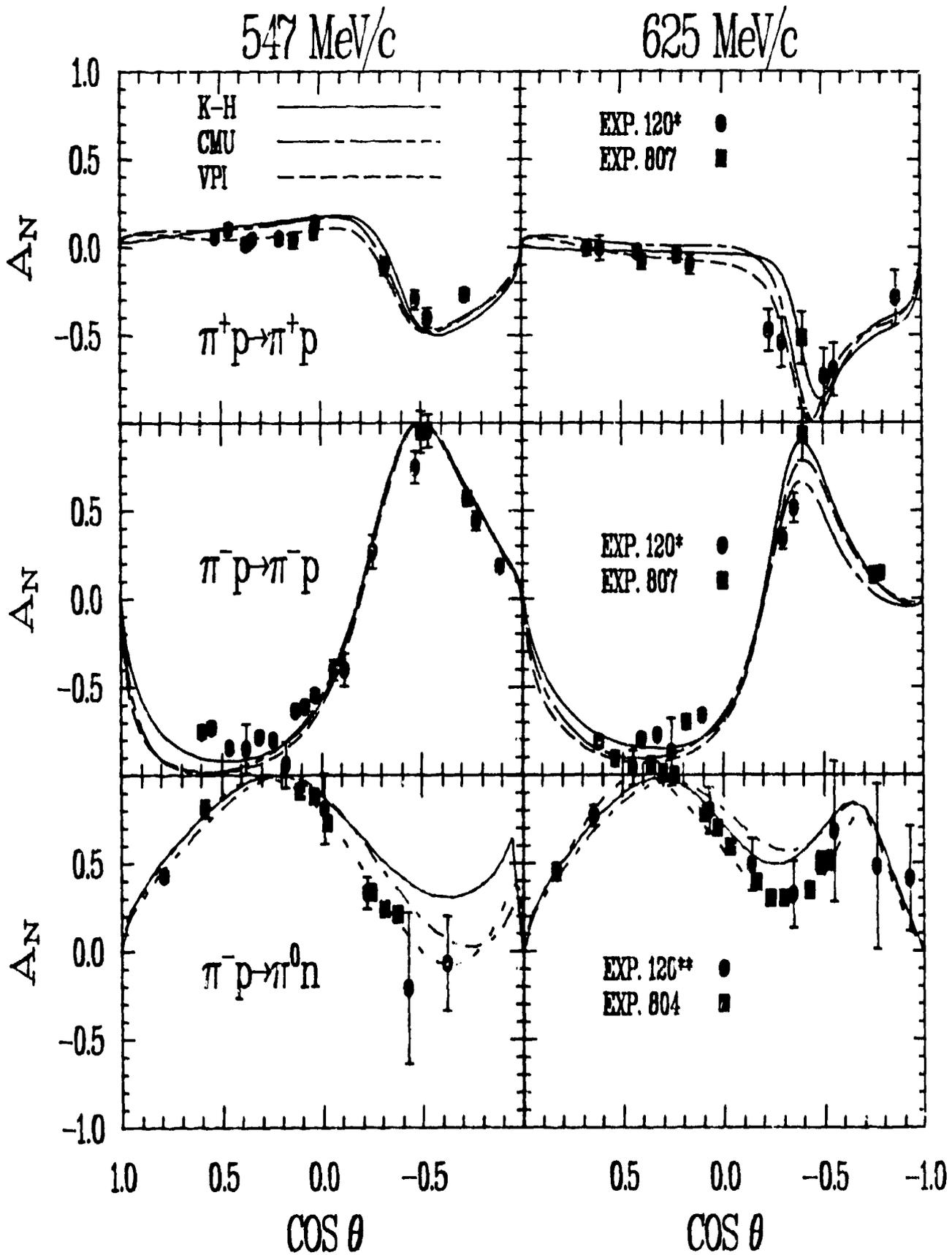
The main experimental groups currently active in this area are at LAMPF<sup>1-3</sup> and Leningrad<sup>4-6</sup>. Groups from each laboratory have measured differential cross sections and analyzing powers,  $A_N$ , for  $\pi^+p \rightarrow \pi^+p$  and  $\pi^-p \rightarrow \pi^-p$ . The LAMPF groups have also measured these observables for the charge exchange reaction,  $\pi^-p \rightarrow \pi^0n$ . There are active groups from each laboratory involved in measuring the spin rotation parameters, A and R, by scattering from targets which are polarized in the scattering plane and measuring the components of polarization of the recoil protons in that plane.

Recently published and soon-to-be-published results for the analyzing powers for all three reactions are shown in the figure. Results from the three major PWA's are also plotted. There is good agreement among the PWA's and our data for the charged-particle final states. The present data have served to reduce substantially the errors on single-energy analyses<sup>15</sup>. Note the square points at 547 MeV/c for  $\pi^-p$  and at 625 MeV/c for both  $\pi^+p$  and  $\pi^-p$ . These are measurements of P, the transverse polarization of the outgoing proton, measured with the same polarimeter that is currently being utilized in measurements of the spin rotation parameters.

The PWA's do not agree with one another as well for the charge exchange reaction. Our data consistently favor the VPI analysis. While it is tempting to conclude that these results are evidence for a split  $P_{11}$ , it is prudent to await future results from the other PWA groups as these data are incorporated into their analyses. This work was supported in part by the United States Department of Energy and the National Science Foundation.

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Analyzing Powers for All Final Charge States in the Pion-Nucleon System